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US Dept. of Commerce Pat. &amp; Trademark Office

Attorney's Docket No.

21306

TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 USC 371

US. Application No. (if known)

09/424272

INTERNATIONAL APP. NO.  
PCT/RO98/00006

INTERNATIONAL FILING DATE  
20 May 1998

PRIORITY DATE CLAIMED  
21 May 1997

TITLE OF INVENTION

THREE-DIMENSIONAL OPTICAL MEMORY WITH FLUORESCENT PHOTOSENSITIVE MATERIAL

APPLICANT(S) FOR DO/EO/US

Eugen PAVEL

Applicant herewith submits to the United States Designated/Elected Office (DO/EU/US) the following .

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 USC 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 USC 371.
3. ☐ This is an express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 USC 317(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed IN ENGLISH (35 USC 371(c)(2)).
  - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau.
  - b. ☐ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Patent Office.
6. ☒ A translation of the International application into English.
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 USC 371(c)(3)).
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau.
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 USC 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 USC 371(c)(4)).
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 USC 371(c)(5)).

Items 11. to 16. below concern documents or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An Assignment for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
 ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items of information.
  - Small-entity Statement
  - Drawing (2 sheets)
  - References
  - PTO-1449

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## 17. The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search report has been prepared by the EPO or JP ..... \$840.00

Int'l prel. exam. fee paid to USPTO (37 CFR 1.482) ..... \$670.00

No int'l prel. exam. fee paid to USPTO (37 CFR 1.482)

but int'l search fee paid to USPTO (37 CFR 1.445(a)(2)) ..... \$760.00

Neither int'l prel. exam fee (37 CFR 1.482) nor

int'l search fee (37 CFR 1.455(a)(2)) paid to USPTO ..... \$970.00

Intl. prel. exam. fee paid to USPTO (37 CFR 1.482)

and all claims satisfied provisions of PCT Art. 33(2-4) ..... \$96.00

ENTER APPROPRIATE BASIC FEE AMOUNT

## CALCULATIONS PTO USE ONLY

\$970

Surcharge of \$130.00 for furnishing oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

CLAIMS	NO. FILED	NO. EXTRA	RATE		
Total claims	3	0	\$18	\$0	
Ind. claims	0	0	\$78	\$0	
MULTIPLE DEP. CLAIM(S) (if applicable) (see prel. amt.)			260		
TOTAL OF ABOVE CALCULATIONS				\$970	
Reduction of 1/4 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (37 CFR 1.2, 1.27, 1.28)				\$485	
SUBTOTAL				\$485	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).					
TOTAL NATIONAL FEE				\$485	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The Assignment may be accompanied by an appropriate PTO-1595 cover sheet (37 CFR 3.28, 3.39)					
TOTAL FEES ENCLOSED				\$485	
				Amt to be refunded	
				Amt to be charged	

a. ☒ A check in the amount of \$485.00 to cover the above fees is enclosed

A check in the amount of \$ to cover recordal of the Assignment

b. ☐ Please charge my deposit account 18-2025 \$ to cover the above fees. A copy of this sheet is enclosed.c. ☒ The commissioner is authorized to charge any additional fees which may be required or credit any overpayment to deposit account 18-2025. A copy of this sheet is enclosed

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:

**The Firm of Karl F. Ross P.C.**  
**5676 Riverdale Ave. Box 900**  
**Riverdale (Bronx), NY 10471**

Herbert Dubno, Reg. No. 19,752

09/424272

21306

420 Rec'd PCT/PTO 18 NOV 1999

IN THE U.S. PATENT AND TRADEMARK OFFICE

Inventor                   Eugen PAVEL  
Patent App.               Not known (US Nat'l phase of PCT/R098/00006)  
Filed                     Concurrently herewith  
For                       THREE-DIMENSIONAL OPTICAL MEMORY WITH  
                          FLUORESCENT PHOTSENSITIVE MATERIAL  
Art Unit                  Not known  
Hon. Commissioner of Patents  
Washington, DC 20231

**PRELIMINARY AMENDMENT**

Prior to examination of the above-identified application,  
please amend as follows:

In the Claims (amended set o claims 1-3):

Claim 3, line 2, delete "claims 1 and 2", insert instead  
-- claim 1 --.

This preliminary amendment is submitted just to reduce  
claim charges.

Respectfully submitted,  
The Firm of Karl F. Ross P.C.



By: Herbert Dubno, Reg. No. 19,752  
Attorney for Applicant

17 November 1999  
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66311 24272

Serial number : Not known -- US Nat'l phase of PCT/RO98/00006  
 Filed : Concurrently herewith  
 Title : THREE-DIMENSIONAL OPTICAL MEMORY WITH FLUORESCENT  
 PHOTOSENSITIVE MATERIAL  
 Inventor: : Eugen PAVEL

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL-ENTITY STATUS**  
**37 CFR 1.9(f) and 1.27(b) -- INDEPENDENT INVENTOR**

As a below-named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under 35 USC 41(a) and (b) to the Patent and Trademark office with regard to the invention entitled:

**THREE-DIMENSIONAL OPTICAL MEMORY WITH FLUORESCENT PHOTOSENSITIVE MATERIAL**  
described in the specification filed herewith.

I have not assigned, granted, conveyed, or licensed and am under no obligation under contract or law to assign, grant, convey, or license any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention or to any concern which would not qualify as a small-business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☐ no such person, concern, or organization  
☐ persons, concerns, or organizations listed below\*

\* Separate verified statements are required from each named entity having rights to the invention averring to their status as small entities. (37 CFR 1.27).

Full Name: \_\_\_\_\_

Address: \_\_\_\_\_

☐ Individual      ☐ Small-business concern      ☐ Nonprofit Organization

Full Name: \_\_\_\_\_

Address: \_\_\_\_\_

☐ Individual      ☐ Small-business concern      ☐ Nonprofit Organization

I acknowledge the duty to file in this application notification of any change in status resulting in loss of entitlement to small-entity status prior to paying or at the time of paying the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28[b]).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under 18 USC 1001 and that such willful false statements may jeopardize the validity of the application to which this verified statement is directed.

Date: 11/8/1999

  
 Eugen PAVEL

034423 T 1 B 9

THREE-DIMENSIONAL OPTICAL MEMORY  
WITH FLUORESCENT PHOTOSENSITIVE MATERIAL

5

Technical field

10 The present invention relates to a three-dimensional optical memory with fluorescent photosensitive materials and more particularly to a method and device for storage and retrieval digital data, using fluorescence phenomenon. The device presented in the invention is a WORM type storage system (write-once-read-many).

15

Background of the invention

20 It is known that the growing of computer applications has imposed the necessity for memories with huge storage capacity needed for libraries, government agencies, hospitals, etc. The new memories should have the following characteristics: low-cost, small size and low energy consumption.

25 Present memory technologies, such as semiconductor memories, CD-ROMs, rigid and flexible magnetic disks, and magnetic tape store information on a two-dimensional support. Due to their 2-D nature, these memories are not able to provide parallel access, and their access time grows with increasing capacity.

30 A solution is the use of the third dimension. Three-dimensional optical memories have higher theoretical storage capacity than present 2-D memories.

For example, the maximum theoretical storage density for an optical disk is  $1/\lambda^2 = 3.5 \times 10^8 \text{ bits/cm}^2$ , while for a 3-D memory  $1/\lambda^3 = 6.5 \times 10^{12} \text{ bits/cm}^3$  assuming that the same wavelength of light  $\lambda = 500 \text{ nm}$  is used to access the information. In addition, 3-D optical memory have the potential for parallel access, because an entire plane can be read or written in a single operation. 3-D data storage was experimented on holographic memories made by photorefractive materials (D. Psaltis and F. Mok, Scientific American, November 1995, p.52).

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Summary of the invention

It is the object of the present invention to employ the fluorescence phenomenon to provide a WORM type 3-D optical memory. Since the read cycle uses fluorescence rather than changes in absorption a higher sensibility is obtained.

The invention is based on writing and reading the information in fluorescent photosensitive materials namely fluorescent photosensitive glasses ( E. Pavel, L. Tugulea, Journal of Solid State Chemistry, **134**, 362, (1997); E. Pavel et. al., Optics Letters, **23**, 1304, (1998) ) and fluorescent photosensitive vitroceramics created by the author of present invention. Writing and reading of said data are carried out with a confocal microscope. The confocal principle was invented by Marvin Minsky, U.S. Patent No. 3,013,467. A point light source is imaged in the object plane. The emitted fluorescent light is directed to a photomultiplier through a detector pinhole. The pinhole is a spatial filter, which permits the analyzing of the light issued only from the focal plane containing this object. This fact ensures obtaining an improved spatial resolution. A computer displays the point as a pixel on a screen. In order to produce a complete image, the light point is moved over the entire object. The arrangement of the detector pinhole, conjugated to the illumination pinhole, ensures that only information from the focal plane reaches the detector. The confocal principle is especially valuable in fluorescence microscopy, since it almost completely eliminates stray light not coming from focal plane.

Thus the system is able to produce fluorescence images with optimum clarity and resolution of fine details. Confocal system LEICA TCS NT achieves an x-/y-resolution of  $0.18\mu$  (FWHM) and a corresponding z-resolution of better than  $0.35\mu$  (FWHM) at  $\lambda = 488 \text{ nm}$  and  $N.A. = 1.32$ . The analyzed volume of the sample is under  $1 \mu\text{m}^3$ . An improvement of the fluorescence microscopy has been obtained with two-photon process which is used for the excitation of fluorescent photosensitive material. The two-photon microscopy is a non-linear technique that provides intrinsic three-dimensional resolution with negligible out-of-focus photoexcitation. A similar result is obtained if the excitation beam is perpendicular to the fluorescence beam. The writing process consists of the irradiation of fluorescent photosensitive material with a radiation producing a fluorescence modification in the irradiated areas. The reading is obtained by the excitation of material. Non-irradiated areas have a strong fluorescence.

Invention presents the advantage of a novel device for storage and retrieval data having application in computers.

Disclosure of the invention

5 The invention is further illustrated by four examples which disclose the characteristic features of the invention.

The objects, features and advantages of the invention will become clear from the following description set forth below, in conjunction with the drawings, in which:

FIG. 1 is a block diagram for the writing/reading device.

10 FIG. 2 is a diagrammatic view of the confocal microscope.

Referring to FIG. 1 an optical system for recording and reading data on optical memory 1 is shown. The experimental system includes: a confocal microscope 2, vertical scanning systems 3, 7, a radial scanning system 4, a laser (1) 5, laser (2) 6 and an engine 8 used for rotation of the optical memory 1. The writing process consists in the irradiation of a selected volume of memory 1 with a light beam of the laser (1). The volume selection is carried out with said confocal microscope 2, vertical scanning system 3 and radial scanning system 4. The irradiated volume of fluorescent photosensitive materials suffers a transition ( at electronic level for fluorescent photosensitive glasses and at structural level for fluorescent photosensitive vitrocereamics) which produces the fluorescence modification. Two procedures could be used for reading. One of this procedures produces the excitation with one-photon process. Laser (2) and vertical scanning system 7 are used in the optical system. The second procedure, which is based on said two-photon process, directs the beam of laser (1) to the specimen.

25 The confocal microscope (FIG. 2) used in writing processes has the following elements: two pinholes 9, 10, the lens 11, 12, 13, 15, the beam-splitter 14, the laser 5 and the detector 16.

30 The present invention will be illustrated in greater details by the following examples, but the merits thereof are not intended to be limited by the materials, compositions and procedures described in these examples.

Example 1: A Ce, Eu doped fluorescent photosensitive glass is used as a support for the optical memory namely:

$\text{Na}_2\text{O}-\text{P}_2\text{O}_5-0.005 \text{ CeO}_2-0.005 \text{ Eu}_2\text{O}_3$ .

35 Memory writing is carried out with said laser (1) (XeCl laser) at  $\lambda_1 = 308\text{nm}$  and the memory reading is based on said laser (2) Nd:YAG laser with  $\lambda_2 = 532 \text{ nm}$ .

Example 2 : A fluorescent photosensitive glass is the support of optical memory as a variant of Example 1:  $2\text{Na}_2\text{O}-(\text{Y}_{0.94}\text{Eu}_{0.05}\text{Pr}_{0.01})_2\text{O}_3-5\text{P}_2\text{O}_5$ . The writing process uses a two-photon absorption of laser light. The recording is carried out by a tunable Ti:sapphire laser (1) at  $\lambda_1 = 720 \text{ nm}$  with 100fs laser pulses. A Nd:YAG laser (2) at  $\lambda_2 = 532 \text{ nm}$  excites the fluorescent material for said reading process.

Example 3 : A Tb doped fluorescent photosensitive vitroceramic is used for the optical memory (wt%), namely:

10  $\sim 30\text{SiO}_2-45\text{PbF}_2-14\text{Al}_2\text{O}_3-10\text{YF}_3-1\text{TbF}_3-0.05\text{Sb}_2\text{O}_3-0.01\text{Ag}$

The recording and reading are based on the two-photon processes. A tunable Ti:sapphire laser (1) with 100fs laser pulses writes at  $\lambda_1 = 720 \text{ nm}$  and reads at  $\lambda_2 = 750 \text{ nm}$ .

15 Example 4 : A similar fluorescent photosensitive vitroceramic as in Example 3 is used for the optical memory (wt%), namely:

20  $\sim 69\text{SiO}_2-15.3\text{Na}_2\text{O}-5\text{ZnO}-7\text{Al}_2\text{O}_3-0.25\text{Tb}_2\text{O}_3-0.25\text{CeO}_2-0.2\text{Sb}_2\text{O}_3-0.01\text{Ag}-2.3\text{F}-0.7\text{Br}$ . The writing is carried out with a tunable Ti: sapphire laser (1) with 100fs laser pulses using  $\lambda_1 = 720 \text{ nm}$  while for reading is used  $\lambda_2 = 980 \text{ nm}$ .

## 5 CLAIMS

- 10 1. A data storage and retrieval system characterized in that the fluorescent photosensitive glasses are used as information recording medium.
2. A data storage and retrieval system characterized in that the fluorescent photosensitive vitrocereamics are used as information recording medium.
- 15 3. A data storage and retrieval system as in claims 1 and 2 characterized in that it comprises:
- i) a confocal microscope 2;
  - 20 ii) a tunable laser 5, having maximum 100fs light pulses, used in confocal microscope 2 for writing and reading by two-photon process;
  - iii) a vertical scanning system 3 and a radial scanning system 4 used for the movement of writing and excitation beams;
  - 25 iv) a rotating optical memory 1;
  - v) an excitation laser 6, with the beam perpendicular on the fluorescence beam, provided with a vertical scanning system 7 for reading the optical memory by one-photon process.
- 30

35

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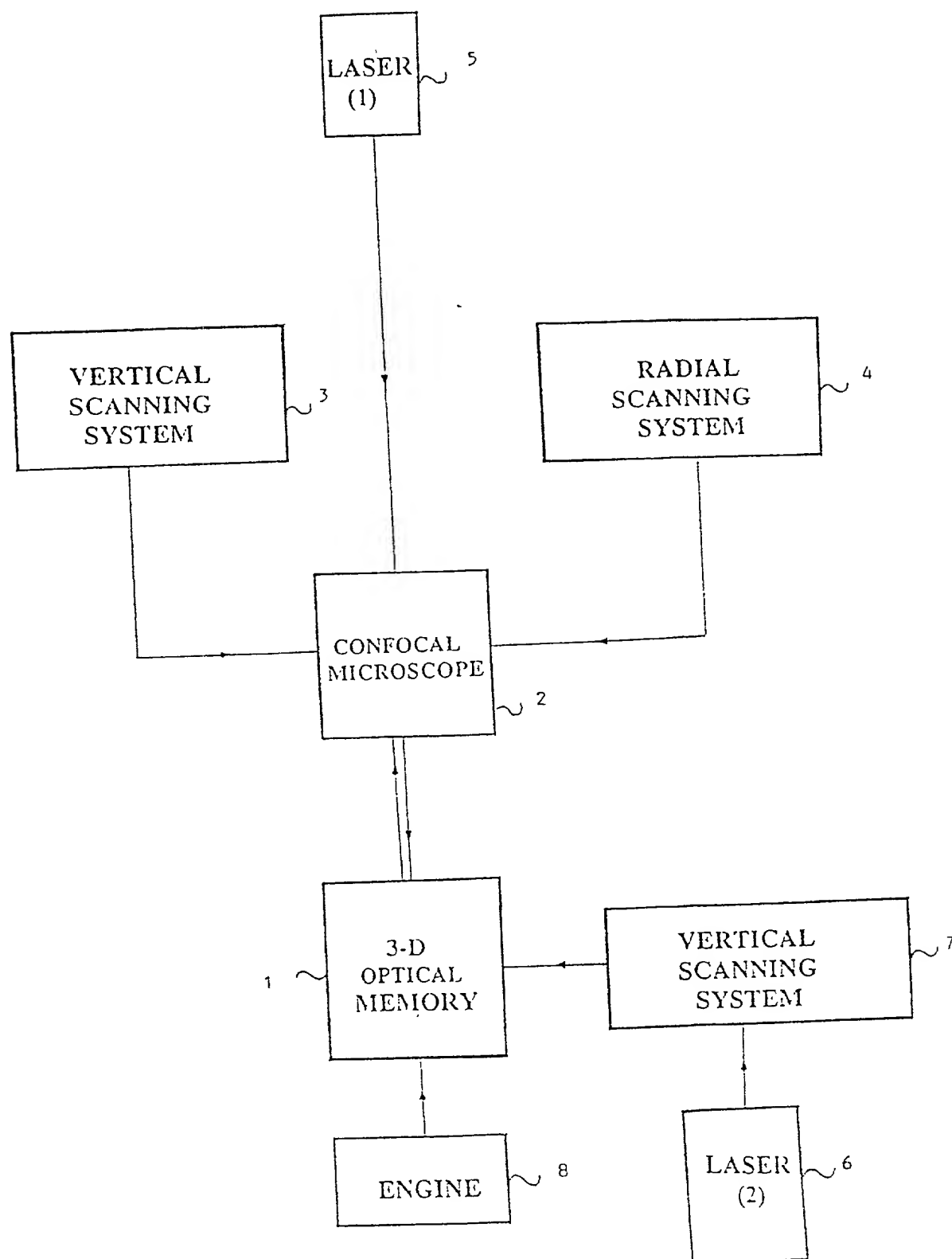


FIG. 1.

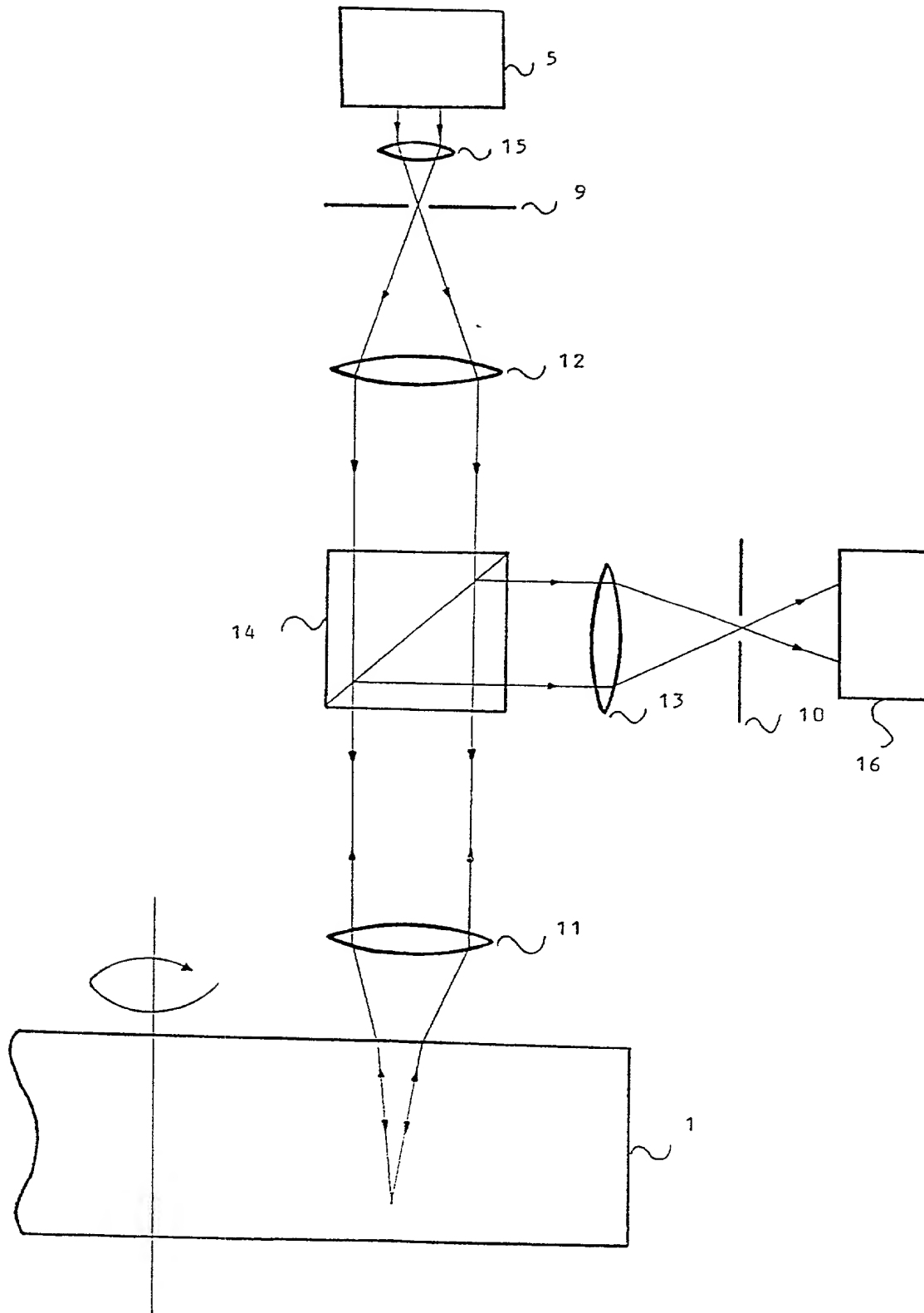


FIG. 2.

**DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that: My residence, post-office address, and citizenship are as stated below next to my name,  
I believe that I am the original, first, and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

**THREE-DIMENSIONAL OPTICAL MEMORY WITH FLUORESCENT PHOTOSENSITIVE MATERIAL**

the specification of which was filed on **20 May 1998** as PCT application **PCT/RO98/00006**.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 USC 119 of any foreign applications for patent or inventor's certificate listed below and have also identified below any foreign applications for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

**Prior Foreign Applications**

Country	Number	Filing Date	Priority claimed
RO	97-00928	21 May 1997	Yes

I hereby claim the benefit under 35 USC 120 of the United States Application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States Application(s) in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose material information as defined in 37 CFR 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Serial Number	Filing Date	Status
PCT/RO98/00006	20 May 1998	Pending

I hereby appoint as attorneys to prosecute this application and to transact all business connected therewith: **Herbert Dubno**, Reg. 19,752; **Jonathan Myers**, Reg. 26,963; **Andrew Wilford**, Reg. 26,597 and each of them individually.

Address all correspondence to:

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**Customer Number 000535**

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**Riverdale (Bronx), New York 10471-0900**

Direct all telephone calls to: (718) 884-6600

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole inventor:

**Eugen PAVEL**

Inventor's signature

Date:

**11/08/1999**

Residence: **Bucharest, Romania**

Citizen of **Romania**

Post-office Address: **Calea Mosilor 274, APT. 34, R-73252 Bucharest, Romania**

**ROX**